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PROCUREMENT SECTION
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progress in
SCREWWORM ERADICATION

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Progress in Screwworm Eradication

Facts About Screwworms

Screwworms, the larvae or maggots of the screwworm fly *(Cochliomyia hominivorax)*, attack all warmblooded animals, including humans, wildlife and pets. The worms feed on healthy flesh in open wounds, unlike blowfly maggots which feed only on dead or diseased tissue. Screwworm infestations can seriously injure, maim or kill infested animals, particularly if wounds are left untreated and become reinfested. Economic losses—from death, crippling, weight losses, increased susceptibility to diseases and labor costs to inspect and treat animals—can be great.

The screwworm fly is about twice the size of a common housefly. It has orange-colored eyes and a bluish-green body with three dark stripes along the back. The fly is rarely seen except around animal wounds.

The female screwworm fly usually mates only once in her lifetime. This mating fertilizes all her eggs, which she lays in batches of up to 400 along the edges of open wounds. Within 12 to 24 hours, the eggs hatch into tiny larvae which burrow deep into the wound to feed. The larvae are difficult to detect in a wound at this stage, since only their posterior ends protrude. With their rasping mouthparts, the larvae tear at the wound and feed on the fluid exudate.

As the worms feed, they increase the size of the original wound, which in turn attracts more female screwworm flies. These multiple infestations can cause death in the host animals if left untreated. Grown steers have been killed in 10 days.

The worms grow to about one-half inch in length after 5 to 7 days of feeding. When fully developed, they drop from the wound, burrow into the soil and form brown, tough-shelled puparia (cocoons) which protect the developing flies. The screwworm fly emerges from the pupal casing after about a week in warm weather (as long as 65 days in cold weather). After 3 days it is ready to mate. The screwworm life cycle averages about 3 weeks.

Weather is an important factor in the location, spread, and severity of screwworm infestations. Warm, humid weather encourages screwworm development and activity while extremely high or low temperatures and drought tend to limit populations and movement.

As screwworms cannot survive extreme cold, their overwintering areas (areas where the fly can survive year round) are normally confined to tropical and subtropical regions. A mild, moist winter usually contributes to greater spread and more danger of reinfestation in screwworm-free areas.

Research has shown that a screwworm fly can migrate up to 180 miles during its lifetime. Of course, larvae may be inadvertently transported for thousands of miles through shipments of infested animals.

The Screwworm and Its Past

The screwworm fly is known scientifically by the name *Cochliomyia hominivorax* (Coquerel), but not until 1933 was any clear distinction made between this parasitic insect and the common blowfly species *Cochliomyia macellaria* (Fabricius), which had been known since the late 18th century. For over a hundred years, it had been assumed that maggot infestations in living animals were those of blowflies feeding on the decaying tissues around wounds and sores—just as blowflies feed on the carcasses of dead animals. These larvae, or maggots, were called screwworms because of the circular rows of spines around their bodies, which made them resemble the common wood screw.

Screwworm infestations in living animals were reported in the western States as early as 1825. Destruction caused by the pest increased over the years to the point where livestock production became unprofitable in some areas. Home remedies for treating infestations were ineffective, and by the turn of the century, ranchers were appealing to the Government for help.

The U.S. Department of Agriculture (USDA) started research on screwworms in 1913, but these early studies failed to show the distinction between parasitic and non-parasitic infestations. In 1929, the USDA's Bureau of Entomology and Plant Quarantine established a station for continued research at Menard, Tex. This station was subsequently moved to Kerrville, Tex., and expanded.

At the new research station, insect toxicologists and entomologists concentrated on measures to protect wounds against screwworms—an effort that advanced rapidly when the team developed a way to rear large numbers of screwworms artificially, thereby obtaining adequate numbers for tests. Among the various toxic chemicals tested, No. 62—diphenylamine—proved the most effective as a wound dressing. When dissolved in benzol and thickened with a turkey-red-oil wetting agent, this became an effective larvicide. The preparation was further stabilized with the addition of lampblack, and became the well-known "Smear 62". For years this was the only relief from screwworm infestations. Organophosphorus compounds have replaced Smear 62 in recent years.

Even with an effective wound dressing, screwworm infestations continued. Constant vigilance was needed to protect livestock. The trapping of immense numbers of blowflies over several years brought no appreciable reduction in the number of infestations. At this point, extensive research on the screwworm life cycle was undertaken, and in 1933, a clear distinction was finally made between the parasitic screwworm and the non-parasitic blowfly.

By the time screwworms were clearly identified, they had spread to Florida and other southeastern States, where they caused heavy losses among livestock, pets and wildlife. As in the Southwest even humans occasionally became infested.

Research on the effective method of screwworm control or eradication was suspended during World War II, but resumed immediately thereafter under a team including, among others; Dr. E. F. Knipling, Dr. R. C. Bushland, Dr. A. W. Linquist, A. H. Baumhover, A. J. Graham, D. E. Hopkins, Frank Dudley, and Weston New.

Because the female screwworm fly usually mates only once, it was proposed that if large numbers of male screwworm flies could be sexually sterilized and distributed throughout infested areas, natural reproduction would be stopped if eggs were not produced or if those produced were not fertile.

An intensive search was launched, therefore, to find an effective, economical means of sterilizing large numbers of male screwworm flies. It was found that screwworm pupae, just before emerging as flies, could be sterilized by exposure to X-rays. Further research, with assistance from the Atomic Energy Commission, showed that sterility could be produced through exposure to gamma rays, using Cobalt-60 as a radioactive source.

The Southeast Eradication Program

To test the "sterile male technique" theory, USDA scientists sought out an infested area isolated by natural barriers from other infested areas to eliminate the problem of reinfestation by migrating flies. In 1954, the Dutch West Indies island of Curacao, 50 miles off the northeastern coast of South America, was selected for the screwworm eradication experiment. The test was successful. Screwworm egg masses, collected from wounded animals, showed a rising percentage of sterile masses compared to fertile masses. The number of infestations dropped steadily, and after 4 months, no more egg masses or infestations were reported. Curacao—the first screwworm eradication success—remained screwworm-free for more than 20 years but recently suffered a reinvasion of screwworms.

The Curacao experiment captured the interest of southeastern livestock producers. If screwworms could be eliminated within a small, isolated area, could they not be eradicated over a larger isolated area—such as the southeastern United States? Until 1933, the southeastern States had been free of screwworms. The movement of infested cattle into southern Georgia enabled screwworms to spread into Florida, where they became established and survived year round. From then on, they were a major pest of the region, often ranging northward during the warm seasons into all the southeastern States as far north as the Carolinas.

In 1957, preliminary tests in Florida showed promising results. The Florida legislature shared the costs of the 2-year eradication program conducted in cooperation with the USDA. The effort was further supported by Georgia, South Carolina, Alabama, and Mississippi in a regionwide cooperative program authorized by Congress. The eradication effort began in 1958 under joint direction of USDA's Agricultural Research Service and the Florida Livestock Board.

A vital ingredient in the southeastern program was producer cooperation. In order to be effective, a ratio of 10 sterile flies to each fertile fly was, and is, necessary. It was up to producers to help reduce the fertile fly population by inspecting their animals frequently for infested wounds and treating all infestations and wounds with an approved insecticide. They also helped by postponing surgical operations—such as castrating and dehorning—until cool weather helped reduce the fly population. Ranchers were urged to send in worm samples for identification to help pinpoint areas of screwworm infestation.

The flies needed in enormous numbers for the southeastern program were reared in Sebring, Fla., in an abandoned airplane hangar modified as a sterile fly production plant. For the first time, a parasitic insect was mass-reared and sterilized in an industrial type operation. Twenty aircraft dispersed the sterile flies in small cardboard boxes. Livestock inspection stations were established along the Mississippi River to prevent infested livestock from moving east and reinfesting the area.

By the end of 1959, the Southeast was free of screwworms. The 2-year campaign cost about $11 million—eliminating the annual $20 million losses caused by screwworms in the southeastern States previously.

The Southwest Eradication Program

Success of the screwworm eradication program in the Southeast led western ranchers to request similar efforts in their region. Elimination of this destructive pest would relieve the region of losses estimated in excess of $100 million annually.

But screwworm eradication in the Southwest was clouded by several problems not present in the isolated southeastern region: screwworm overwintering areas in the Southwest were larger, extending continuously southward into Mexico; screwworm migrations across the 2,000-mile U.S.-Mexico border presented a tremendous potential for reinfestation; climatic conditions and livestock populations were entirely different from the Southeast situation.

Nevertheless, State and Federal officials decided to go ahead with the Southwest program—with authorization by Congress and substantial support from the livestock industry. In addition to State and Federal appropriations, southwestern livestock producers, represented by the Southwest Animal Health Research Foundation (SWAHRF), raised and donated $4.5 million to eradicate screwworms.

The southwestern eradication program, which began in February 1962, had two principal objectives: (1) eradicating the screwworm fly from overwintering areas in the Southwest; and (2) stopping northward migrations by establishing and maintaining a screwworm barrier zone along the Mexico-U.S. border.

Drawing heavily on experience gained in the southeastern eradication effort and using funds largely donated through SWAHRF, a sterile fly production plant was constructed by modifying a hangar at the former Moore Air Base at Mission, Tex. Federal expenditures were matched by those of the five States comprising the original eradication area—Texas, New Mexico, Arkansas, Louisiana and Oklahoma. The new plant was designed to rear more than 150 million sterile flies per week.

As in the southeastern eradication program, success depended on rancher cooperation. Livestock producers were asked to check their animals regularly, to treat every wound and infestation and to send worm samples to the Mission laboratory for identification.

The eradication program proved an outstanding success. By September 1963, screwworm infestations within the original five-State area had been reduced by 99 percent, and, with the cooperation of the Mexican Government, an artificial barrier zone had been established along the Rio Grande.

By 1964, overwintering screwworm populations had been eradicated from the original five-State eradication area, and by the end of 1966, the last self-sustaining screwworm population had been eliminated in Arizona and California. Also, 1975 saw the successful completion of a 4-year cooperative program with the U.S. Air Force to eradicate screwworms from Puerto Rico and the Virgin Islands.

The Barrier Zone

Screwworm eradication in the Southwest did not guarantee the region against annual reinfestations from Mexico, though. The screwworm barrier zone was established to prevent or minimize such reinfestations. The necessity for such a zone was obvious, since a screwworm fly can migrate more than 100 miles in search of a suitable host animal. A single infestation can produce more than 300 flies within 21 days and any warm-blooded animal with an untreated wound—even as small as a tick bite—is a potential host.

The barrier zone operated on the strategy of (1) screwworm surveillance and prevention throughout the region; (2) case reporting through submission of worm samples and egg masses and; (3) aerial release of sterile flies over generally infested areas and individual sites of infestation.

Cooperation of ranchers, veterinarians, county agents, livestock inspectors and others was again an essential element in the successful barrier program. Treating wounds and submitting samples enabled program officials to utilize sterile flies most effectively.

The Screwworm Plant at Mission

The Southwest Screwworm Eradication Program and the expanded eradication activities in northern Mexico are directed from the sterile fly production plant at Mission, Tex. The mailing address is: Southwest Screwworm Eradication Program, APHIS, USDA, Box 969, Mission, Tex. 78572.

The artificial rearing and distribution of over 100 million sterile flies each week is a highly complex operation involving entomologists, engineers, pilots, veterinarians, administrators and plant personnel. Some 400 employees, working three shifts a day, 7 days a week, collect fertile screwworm eggs, raise the larvae, irradiate and store the pupae, package and then release the flies from the program's fleet of aircraft.

The plant, which has over 81,500 square feet of floor space, is sealed to prevent the escape of fertile flies or contaminated materials. All employees and visitors must observe biological security by changing into uniforms and passing through a security area in order to enter the plant and by showering with larvacidal soap before leaving. All materials must be incinerated or "sterilized" before leaving the plant, including heavy hardware which must pass through a special "hot room" before removal.

Plant operations at Mission are based on the techniques developed at Sebring, Fla. Fertile eggs are collected from the fertile fly colony. The tiny larvae hatched from the eggs feed in warm, shallow vats on a medium simulating the flesh of warmblooded animals. The larvae mature in 5 to 7 days and crawl off the vats, falling into channels of flowing water which carry them to a separator. They are then placed in sawdust-filled boxes for pupation. The pupae are separated from the sawdust after 10 hours and held in a temperature- and moisture-controlled room. After about 6 days, the pupae are placed in metal canisters and exposed to approximately 7,000 roentgens of gamma radiation emitted from radioactive Cesium-137. Canisters of irradiated pupae are conveyed automatically to the packaging section where the pupae are measured into cardboard release boxes. When the flies emerge from their pupal cases, the boxes of flies are ejected from aircraft over infested areas.

Flies are released from the aircraft through specially constructed chutes that eject and open the boxes at predetermined rates. Normally, the planes fly on parallel routes approximately 5 miles apart. Other aircraft fly "hot-spot" and "strategic" sterile fly release missions. These operations are supported by livestock inspectors who visit ranches in the infested areas, mark the sites for aircraft where necessary, and encourage ranchers to inspect their livestock, spray their herds and submit larvae samples for identification.

To form the APHIS Mission plant, Field Survey and Identification, Methods Development, Plant and Aircraft Maintenance and Administrative Section combine with the sterile fly rearing operations. But the importance of owner cooperation and screwworm-preventing husbandry practices cannot be overemphasized. Sterile flies alone do not eradicate screwworms.

The Joint Mexico-U.S. Screwworm Eradication Program

The barrier zone alone cannot prevent screwworms from causing damage to Southwest livestock. The disastrous 1972 season demonstrated clearly that a more effective barrier zone was needed. The United States and Mexico agreed jointly to eradicate screwworms from most of Mexico north and west of the narrow Isthmus of Tehuantepec in Southern Mexico. To that end, U.S. Secretary of Agriculture Earl L. Butz and Mexican Secretary of Agriculture and Livestock, Manuel Aguirre, signed an international agreement on August 28, 1972, which authorized the joint Mexico-U.S. Commission on Screwworm Eradication. The Commission consists of the program director and co-director, representing Mexico and the United States respectively, and eight Commission members—four each from Mexico and the United States. The Mexico program—headquartered at Leibnitz No. 20-12/Apartado Postal M-2890/Mexico, D.F.—is funded from U.S. (80 percent) and Mexico (20 percent) sources.

The 500 million sterile flies reared each week at the new Mexican plant located near Tuxtla Gutierrez in the Isthmus of Tehuantepec and the Mission plant will be released throughout Mexico until screwworms have been eradicated. Eradication is estimated to take from 5 to 7 years. After eradication, a new barrier zone will be maintained across the Isthmus at approximately one-fourth the cost necessary to maintain the present zone along the U.S.-Mexico border.

What the Public Can Do

Before screwworm eradication, ranchers were alert for screwworms. That principle should be just as valid today. Every infestation that is prevented or treated increases the potential effectiveness of the sterile screwworm flies. Every infestation that goes untreated provides an opportunity for screwworms to multiply to dangerous levels.

The following measures are recommended for the maximum effect in preventing or eliminating screwworms.

(1) Inspect animals at least twice a week. Screwworm larvae reach maturity in less than 7 days.

(2) Treat every wound with an approved preparation.

(3) Spray animals when screwworm danger is high, and after livestock surgery or shearing of sheep and goats.

(4) Collect larvae or egg masses that are found in or near wounds and send them in for identification. Free mailing kits are available from State and Federal livestock inspectors, veterinarians, county agents, and at locations such as livestock markets, feed stores and animal health offices.

(5) Avoid surgery during seasons of high screwworm activity. Branding, dehorning, castrating, docking and shearing should be completed before screwworms build up in the spring and fall.

(6) Manage animals so as to avoid unnecessary injuries. Avoid crowding; keep gates and corrals free of protruding nails and other sharp projections.

(7) Observe all regulations governing livestock movements from areas of seasonal screwworm infestations. Never move an infested animal.

Pet owners, veterinarians, market operators, hunters, zoo keepers, and medical doctors also can help by watching for and reporting screwworm infestations.

The Future

The success of the Mexico-U.S. Screwworm Eradication Program will depend on the support given the program by livestock producers, veterinarians, and all others involved in keeping or handling animals. Regardless of proximity to the barrier zone or an eradication area, these key people must remain alert to the possibility of screwworm infestation. Inspecting animals, treating wounds, and reporting cases are critical elements of eradication.

Because it is predominantly tropical, Mexico presents problems not encountered within the United States—such as high rainfall and temperatures favorable to year round screwworm survival. Some experience in tropical screwworm eradication was gained, though, during the recent successful eradication effort in Puerto Rico and the Virgin Islands.

USDA's Agricultural Research Service continues to study eradication methods and techniques, screwworm fly attractants, new sterilizing techniques, and the behavior of various strains of screwworm flies. Epidemiological studies are being refined to identify environmental factors that affect the activity and distribution of screwworms.

Ranchers and animal health officials on both sides of the border now have a great incentive to push toward the successful completion of the Mexico-U.S. Screwworm Eradication Program. It is now possible to rid the North American continent of screwworms and establish a secure and economical barrier against future invasions of this pest. Experience leaves no doubt that success will be well worth the effort.

GPO 904-294

SCREWWORM LIFE-CYCLE

(AVERAGE TIMES IN NATURE)